TRANSLATION E 4

[19] FEDERAL REPUBLIC OF GERMANY

GERMAN PATENT OFFICE

[12] **Preliminary Published Application**

[10] **DE 44 10 932 A1**

[51] Int. Cl.[6]:
B 29 C 47/10
B 29 C 47/60
B 29 C 47/40
B 29 C 45/60

[21] **Application number:** P 44 10 932.6

[22] **Date of filing:** March 29, 1994

[43] **Date of publication of application:** October 5, 1995

[71] **Applicant:**
Weber, Johannes, Ph.D., Engr.
96317 Kronach
Germany (DE)

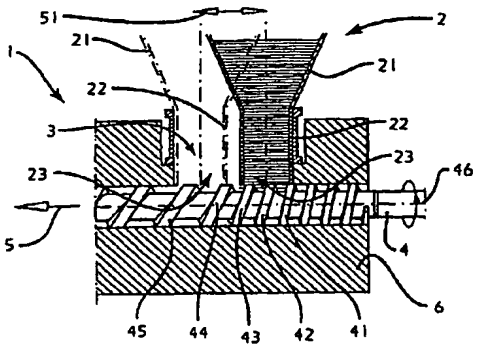
[72] **Inventor:**
same as applicant

[74] **Representatives:**
Schaumburg, K., Grad. Engr.;
Thoenes, D., Grad. Phys., Ph.D. nat. sci.;
Thurn, G., Grad. Engr., Ph.D.,
Patent Attorneys
81679 Munich
Germany

An examination request pursuant to § 44 of the German Patent Law (PatG) has been filed.

[54] Extruder

[57] An extruder (1) has a filling device (2) for dropping material through a filling opening (3) onto at least one screw (4, 4'). At least in the area of the filling opening (3), the screw (4, 4') has screw flights (41, 42, 43, 44, 45) whose pitches increase in the extrusion direction (5). In the area of the filling opening (3), the material feed can be adjusted by means of the filling device (2) to screw flights (41, 42, 43, 44, 45) having different pitches.



DE 44 10 932 A1

DE 44 10 932 A1

Description

The invention relates to an extruder according to the generic part of Claim 1.

Extruders have one or more screws to which material is fed in order to be processed. For this purpose, there is a filling opening through which the material is fed into the screw from a filling device. In order to ensure proper operation of the extruder on the one hand and the desired quality of the extruded product on the other hand, the material feed has to be regulated in such a way that the extruder always receives the right amount of material. From practical applications and publications, the person skilled in the art is familiar, for example, with weighing conveyor belts and metering devices that end in front of the filling opening. These devices allow the quantity of material fed in to be regulated on the basis of its weight or throughput rate. Such regulation techniques, however, are complex and imprecise.

The invention is based on the objective of creating an extruder in which the quantity of material fed in can be determined in a simple and precise manner.

This objective is achieved with an extruder according to Claim 1.

Thus, according to Claim 1, at least one screw of an extruder of the generic type, at least in the area of the filling opening, has screw flights whose pitches increase in the extrusion direction at least in certain areas. Moreover, the filling device is such that it allows a regulation of the material feed in the area of the filling opening onto screw flights having different pitches. Consequently, the quantity filled into the extruder can be set volumetrically.

Thus, with the extruder according to the invention, the quantity of material fed in is determined by the space defined by the screw flights. Corresponding to the different pitches of the screw flights, the spaces between them also vary, thus allowing an appropriate dimensioning of the material feed by selecting the specific screw flights between which the filling device feeds the material.

Consequently, according to the invention, the quantity of material fed into the extruder is determined volumetrically. Since it is then possible to ignore other physical parameters such as, for example, weight or flow rate of the material for dimensioning the quantity and moreover since the quantity of material fed in is regulated directly in the extruder, the material feed with the extruder according to the invention can be carried out precisely and simply.

An advantage of the invention is that complex devices such as weighing conveyor belts or metering devices can be dispensed with. This advantageously enhances the reliability of the extruder since its operation does not depend on an especially precise functioning of other devices.

Another advantage of the invention lies in the fact that the quantity of material fed in can be regulated particularly precisely, for example, in order to compensate for fluctuations of physical variables of the material to be processed.

According to Claim 2, it is provided that the pitches of the screw flights of the screw change incrementally or continuously. Pitches of the screw flights that increase incrementally in the extrusion direction have the advantage that it is possible to set discrete values – which are very easy to determine in advance – for the material feed. Intermediate values of these quantities of material, however, can also be achieved by regulating the filling device appropriately. If the pitches of the screw flights change continuously, this has the advantage that the material feed can be very finely adjusted and its relationship

with the positioning of the filling device relative to the screw flights can be configured simply and continuously, for example, linearly.

In a preferred embodiment according to Claim 3, the filling device has a feed hopper. Thus, the material feed in the area of the filling opening can be adjusted by means of the feed hopper to screw flights having different pitches. According to Claim 4, another preferred feature in an extruder according to the invention is that the filling device or if applicable, its feed hopper has an outlet whose effective outlet opening, in the area of the filling opening, at least along the extrusion direction, can be varied relative to the screw flights having different pitches. In one variant of this embodiment, it is provided that, in the area of the filling opening, the material feed can be adjusted to screw flights having different pitches, particularly by means of the outlet.

Building upon this, in another embodiment described in Claim 5, there is an outlet opening with a pre-specified constant outlet surface area. Then, in order to vary the effective outlet opening alone or together with the filling device or if applicable, together with its feed hopper, the outlet is adjustable, at least along the extrusion direction.

The above-mentioned embodiment is refined by the features of Claim 6 in that the filling device or only its outlet, for example, can be moved or swiveled along the extrusion direction, at least essentially in the area of the filling opening.

The selection of the quantity of material fed in according to the above-mentioned embodiments is thus carried out in that the filling device, its feed hopper or outlet is positioned relative to the screw flights having different flights in such a way that the material is only fed into the screw at a certain area and is volumetrically dimensioned by the space defined by the screw flights.

According to another embodiment of the present invention, the outlet opening can have a variable outlet surface area that can be changed relative to the screw flights having different pitches, at least along the extrusion direction, as is described in Claim 7. In this embodiment, the filling device or its feed hopper can be positioned with respect to the screw so as to be stationary. In this embodiment, it is not necessary to move the entire filling device or its feed hopper or the outlet in order to set the quantity of material to be fed in. In the embodiment according to Claim 8, it is sufficient, for example, for the outlet to have a variable wall section with which the outlet surface area of the outlet opening can be varied. Here, it is merely necessary to change the position of the wall section in order to regulate the material feed into the screw. Preferably, according to Claim 9, the variable wall section can be moved or swiveled at least in the area of the filling opening of the extruder along the extrusion direction. However, the basic concept of a variable outlet surface area explained above can also be achieved by an outlet made of an elastic material.

According to Claim 10, in another preferred embodiment of the invention, it is provided that the screw(s) is/are arranged so as to rotate in an extrusion cylinder that has its filling opening in the feed zone of the screw(s). If, according to Claim 11, the filling device is arranged on the extrusion cylinder, it is possible to achieve, for example, an especially compact design.

The filling device can be regulated and adjusted especially simply and precisely in order to meter the quantity of the material to be fed in by means of the filling device and/or if applicable, by means of its components when, for this purpose, in the area of the filling opening above the screw flights having different pitches, there are electric and/or hydraulic regulation elements that interact with said filling device or its components and additionally or alternatively those control elements described in Claims 16 and 17.

An especially precise setting and adjustment of the material feed is achieved by the embodiment according to Claim 18 according to which the material feed can be regulated by the filling device while the extruder is in operation. This allows a direct influence on the quality of the extrusion products during the production by regulating the quantity filled into the extruder.

Additional advantageous and preferred embodiments ensue from the other subclaims as well as from the possible combinations of the individually claimed features.

The invention will be described in greater depth below on the basis of embodiments that are shown in the drawing, in which:

Figure 1 – is a longitudinal section through a first embodiment of the invention,

Figure 2 – is a longitudinal section through the embodiment of Figure 1 in a setting for a large quantity of material,

Figure 3 – is a top view of the embodiment of Figure 1, whereby a setting for a small quantity of fed in material is shown and only the outlet of the feed hopper of Figure 1 is shown,

Figure 4 – is a longitudinal section through a second embodiment of the present invention,

Figure 5 – is a representation of the embodiment of Figure 4 in a longitudinal section, whereby a maximum quantity of material feed has been set,

Figure 6 – is a top view of the embodiment of Figure 4, whereby a setting for a small quantity of fed in material is shown and only the variable wall section of the feed hopper of Figure 4 is depicted.

In the drawing that accompanies the following description, the same parts are consistently designated by the same reference numerals. Therefore, the associations and functional interrelationships of the individual components are analogous in the various embodiments.

Figures 1 to 3 show an extruder 1 having two screws of which only one screw 4 can be seen in Figures 1 and 2. The screw 4 is arranged in the extruder housing in such a way that it can be rotated around its longitudinal axis 46, said extruder housing being formed by an extrusion cylinder 6.

The extrusion cylinder 6 has a filling opening 3 that is located in the feed zone of the screw 4. A filling device 2 in the form of a feed hopper 21 is arranged with its outlet 22 in the filling opening 3 so that it can move along the extrusion direction 5.

The screw flights 41, 42, 43, 44 and 45 of the screw 4 in the area of the filling opening 3 have pitches that increase in the extrusion direction 5. In this manner, chambers having different volumes are formed between the pitch sections. By moving the feed hopper 21 of the filling device 2 within the filling opening 3 along the extrusion direction 5 that runs parallel to the longitudinal axis 46 of the screw 4 in the embodiment shown, the chamber volume and thus the filling quantity per rotation of the screw is changed.

The outlet 22 of the hopper 21 has an outlet opening 23 that, when the hopper 21 is moved, is moved over the screw 4 in such a way that it allows material to be fed selectively into the screw flights 41, 42, 43, 44 or 45 or else into intermediate positions thereof. Therefore, as can easily be seen, the crucial aspect is simply where the outlet

opening 23 lies with respect to the area of the screw 4 having screw flights 41 to 45 with different pitches. Therefore, for example, the feed hopper 21 can be swiveled together with the outlet 22 in order to cause the material to drop through the outlet opening 23 onto or between the appropriate flights 41 to 45 of the screw 4. The same effect can be achieved if only the outlet 22 of the feed hopper 21 is moved or swiveled into the area of the filling opening 3.

As can also be seen in Figure 1, the maximum adjustment path of the feed hopper 21 of the filling device 2 is prescribed in the directions of the double arrow 51 by the lengthwise extension of the filling opening 3 along the extrusion direction 5. The two extreme positions of the feed hopper 21 are shown by the depiction using solid lines (minimum filling quantity) on the one hand and by the depiction using broken lines (maximum filling quantity). The position of the feed hopper 21 for the maximum quantity of material fed in is also shown in Figure 2.

Figure 3 shows a top view of the embodiment of Figures 1 and 2, whereby the top part of the feed hopper 21 was left out in order to allow an unimpeded view of the filling opening 3 and of the outlet 22.

The position of the outlet 22 in Figure 3 is the same as in Figure 1, that is to say, the depiction in solid lines indicates the position of the feed hopper 21 or of its outlet 22 in which the quantity of material to be fed into the extruder is set at a minimum since, in the area of the screw flights 41 and 42, the chamber situated in between has the smallest volume of the chambers formed by the screw flights 41 to 45.

The outlet 22 in Figure 3 is shown in the same position as it has in Figure 1. The screw flights 41 and 42 of the screw 4 are visible in the filling opening 3 and through the outlet opening 23 of the outlet 22. The screw 4 is mounted so as to rotate around its longitudinal axis 46, and the second screw 4' is likewise mounted so as to rotate around its longitudi-

nal axis 46'. The screw flights of the second screw 4' are arranged so as to match those of the first screw 4 and they are configured in such a way that the two screws 4, 4' can rotate in opposite directions in the extrusion cylinder 6. The pitches of the screw flights 41 to 45 of the first screw 4 and, in an analogous manner, the corresponding screw flights of the second screw 4' increase continuously or steadily in the extrusion direction 5 (Figure 1).

In Figure 2, underneath the outlet opening 23 of the outlet 22, the screw flights 44 and 45 of the screw 4 can be seen in the area of the filling opening 3. The size of the chamber formed between the screw flights 44 and 45, which has the largest volume among the chambers formed between the screw flight pairs 41/42, 42/43, 43/44 and 44/45, determines the maximum quantity of material to be fed in. However, since the pitches of the screw flights 41 to 45 increase continuously in the extrusion direction 5 (Figures 1 and 2), the depiction of the individual chambers serves only for illustration purposes. In fact, any desired maximum volume between the screw flights 41 and 45 can be set volumetrically as a function of the minimum and maximum pitch of the screw flights.

Figures 4 to 6 show a second embodiment of an extruder 1 that contains two screws 4, 4' that can rotate in opposite directions around their longitudinal axes 46, 46' in the extrusion cylinder 6. In the area of a filling opening 3 provided in the extrusion cylinder 6, the screw 4 has screw flights 41, 42, 43, 44 and 45 with pitches that increase in the extrusion direction. The pitches of the screw flights 41 to 45 change incrementally or step-wise. The screw 4' is shaped exactly like the screw 4 but with the opposite pitch so that the two screws 4, 4' rotate in opposite directions.

In the filling opening 3, there is a feed hopper 21 as the filling device 2, whereby the outlet 22 of the feed hopper 21 has a variable wall section 24. In order to regulate the quantity of material fed into the extruder 1, the outlet opening 23 of the outlet 22 is adjustable in that the variable wall section 24 can be moved in the directions indicated by the double arrow 52 between the position shown with solid lines in Figure 1, and the position shown

with broken lines in the same figure. In this manner, material can be fed, for example, only to the chambers defined by the screw flights 41, 42 and 43, as a result of which a smaller material feed is specified, as shown in Figures 4 and 6. If the variable wall section 24 is moved in the extrusion direction 5 into the position shown in Figure 5, then the material also falls into the chambers delineated by the screw flights 43, 44 and 45. This sets a larger quantity of material to be fed into the extruder.

Therefore, the effective outlet opening 23 of the outlet 22 is set by moving the variable wall section 24. As a function of this setting, material can drop between the screw flights 41 to 45 of the screw and the corresponding screw flights of the screw 4'. Since the pitches of the screw flights 41 to 45 change increasingly in the extrusion direction 5, the quantity of material fed into the extruder 1 can be precisely regulated as a function of the partially or completely filled chambers based on the position of the wall section 24 and finely adjusted.

Consequently, with this embodiment of an extruder, by adjusting the wall section 24, the active or effective outlet opening 23 can be set in such a way that material can be fed into the area of the screws 4, 4' in which there is a screw flight with a desired pitch. The quantity fed in here is determined by the screw flight that is charged with the material flow and that has the greatest pitch.

Due to the incremental change of the pitches of the screw flights 41 to 45, in this embodiment of the extruder 1, very precise discrete values for the quantity of material fed in can be set. Moreover, through intermediate positions of the variable wall section 24, any intermediate values for quantities fed in can also be set.

Thus, in general, the invention is achieved in that the screw has areas with different pitches in the area of the filling opening. This forms chambers having different volumes in between the pitch segments. For example, if the feed hopper outlet is moved axially

within the filling opening or the feed hopper opening is widened or narrowed to areas having another pitch, the chamber volume and thus the filling quantity per screw revolution is changed, so that a volumetric metering of the material is achieved.

The embodiments of the invention described with reference to the drawing serve merely to explain them. The entire scope of the invention is indicated by the claims, all of whose realizations are covered by the invention. The invention is likewise applicable to extruders with one screw or with several screws, which can be configured in such a way that they can rotate either in the same direction or in the opposite direction with respect to each other. Moreover, the invention can also be realized using conical screws. For example, it is also possible to partially or completely cover the filling opening outside of the outlet opening.

List of reference numerals

1	extruder
2	filling opening
21	feed hopper
22	outlet
23	outlet opening
24	variable wall section
3	filling opening
4, 4'	screw
41, 42, 43, 44, 45	screw flights
46, 46'	longitudinal axis of the screw
5	extrusion direction
51	double arrow for the movement of 21/22/33
52	double arrow for the movement of 24
6	extrusion cylinder

Claims

1. An extruder having a filling device for dropping material through a filling opening onto at least one screw, **characterized in that**
at least in the area of the filling opening (3), the screw (4, 4') has screw flights (41, 42, 43, 44, 45), at least in certain areas, whose pitches increase in the extrusion direction (5), and
in that, in the area of the filling opening (3), the material feed can be adjusted by the filling device (2) to screw flights (41, 42, 43, 44, 45) having different pitches.

2. The extruder according to Claim 1, characterized in that the pitches of the screw flights (41, 42, 43, 44, 45) of the screw (4, 4') change incrementally or continuously.

3. The extruder according to Claim 1 or 2, characterized in that
the filling device (2) has a feed hopper (21), and
in that the material feed in the area of the filling opening (3) can be adjusted by means of the feed hopper (21) to screw flights (41, 42, 43, 44, 45) having different pitches.

4. The extruder according to one of the preceding claims, characterized in that
the filling device (2), if applicable, especially the feed hopper (21), has an outlet (22) whose effective outlet opening (23), in the area of the filling opening (3), at least along the extrusion direction (5), can be varied relative to the screw flights (41, 42, 43, 44, 45) having different pitches, and

in that, in the area of the filling opening (3), the material feed can be adjusted to screw flights (41, 42, 43, 44, 45) having different pitches, preferably by means of the outlet (22).

5. The extruder according to Claim 4, characterized in that the outlet opening (23) has a pre-specified constant outlet surface area and, in order to vary the effective outlet opening (23) alone or together with the filling device (2), if applicable, especially together with the feed hopper (21), the outlet (22) is adjustable, at least along the extrusion direction.

6. The extruder according to Claim 5, characterized in that the filling device (2), if applicable, especially the feed hopper (21) or only its outlet (22) can be moved or swiveled along the extrusion direction (5), preferably at least essentially in the area of the filling opening (3) of the extruder (1).

7. The extruder according to Claim 4, characterized in that the outlet opening (23) has a variable outlet surface area that can be changed relative to the screw flights (41, 42, 43, 44, 45) having different pitches, at least along the extrusion direction (5), and in that the filling device (2), if applicable, especially the feed hopper (21), can be positioned with respect to the screw so as to be stationary.

8. The extruder according to Claim 7, characterized in that the outlet (22) has a variable wall section (24) with which the outlet surface area of the outlet opening (23) can be varied.

9. The extruder according to Claim 8, characterized in that the variable wall section (24) can be moved or swiveled along the extrusion direction (5), preferably at least in the area of the filling opening (3) of the extruder (1).

10. The extruder according to one of the preceding claims, characterized in that there is an extrusion cylinder (6) in which the screw (4, 4') is arranged so as to rotate around its longitudinal axis (46, 46'), said cylinder having the filling opening (2) in the feed zone of the screw (4, 4').

11. The extruder according to Claim 10, characterized in that the filling device (2) is arranged on the extrusion cylinder (6).

12. The extruder according to one of the preceding claims, characterized in that, in the area of the filling opening (3) above the screw flights (41, 42, 43, 44, 45) having different pitches, the quantity of material to be fed in is regulated by means of the filling device (2) and/or if applicable, by means of its components (feed hopper 21, outlet 22, wall section 24), and there are electric and/or electronic regulation elements that interact with said filling device or its components.

13. The extruder according to one of the preceding claims, characterized in that, in the area of the filling opening (3) above the screw flights (41, 42, 43, 44, 45) having different pitches, the quantity of material to be fed in is regulated by means of the filling device (2) and/or if applicable, by means of its components (feed hopper 21,

outlet 22, wall section 24), and there are electric and/or hydraulic regulation elements that interact with said filling device or its components.

14. The extruder according to one of the preceding claims, characterized in that, in the area of the filling opening (3) above the screw flights (41, 42, 43, 44, 45) having different pitches, the material feed can be regulated by the filling device (2) while the extruder (1) is in operation.

15. The extruder according to one of the preceding claims, characterized in that a screw (4) is provided and in that the filling opening (3) and the filling device (2) are preferably arranged in such a way that the material is fed onto the screw (4), at least essentially centrally from above.

16. The extruder according to one of the preceding claims, characterized in that two screws (4, 4') are provided and are arranged next to each other, and
in that the filling opening (3) and the filling device (2) are preferably arranged in such a way that the material is fed partially onto each of the screws (4, 4'), at least essentially centrally from above.

17. The extruder according to Claim 16, characterized in that the screw flights of the two screws (4, 4') are configured in such a way that the latter can rotate in the opposite direction.

18. The extruder according to Claim 16, characterized in that the screw flights of the two screws (4, 4') are configured in such a way that the latter can rotate in the same direction.

19. The extruder according to Claim 17, characterized in that the screws (4, 4') are conical.

---

3 pages of appertaining drawings

Translation: Language Solutions
Leonardo and Elise Duvekot
ledtrans@cs.com
September 20, 2003

DRAWINGS - PAGE 1

Number: **DE 44 10 932 A1**
Int. Cl.[6]: **B 29 C 47/10**
Publication date: October 5, 1995

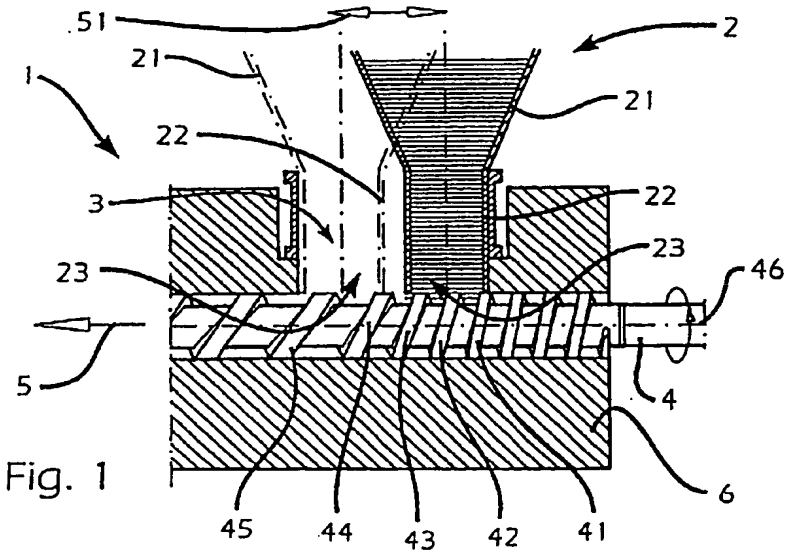


Fig. 1

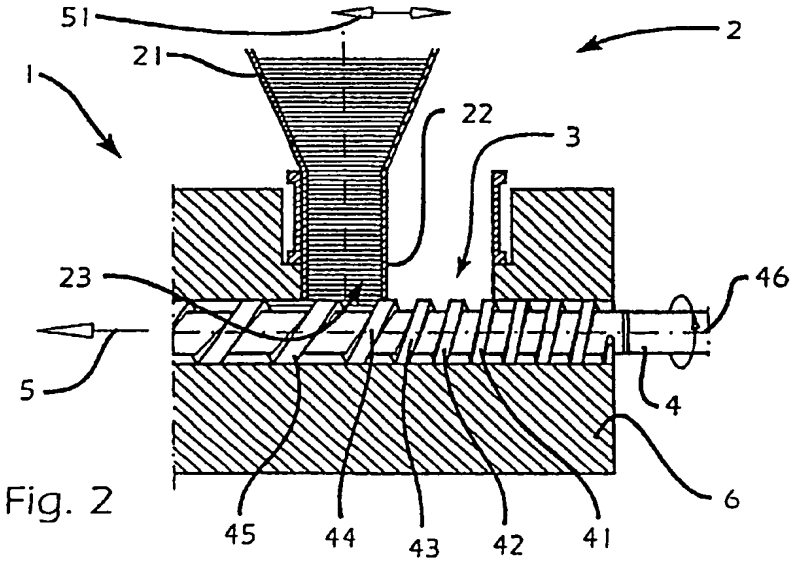


Fig. 2

DRAWINGS - PAGE 2

Number: DE 44 10 932 A1
Int. Cl.[6]: B 29 C 47/10
Publication date: October 5, 1995

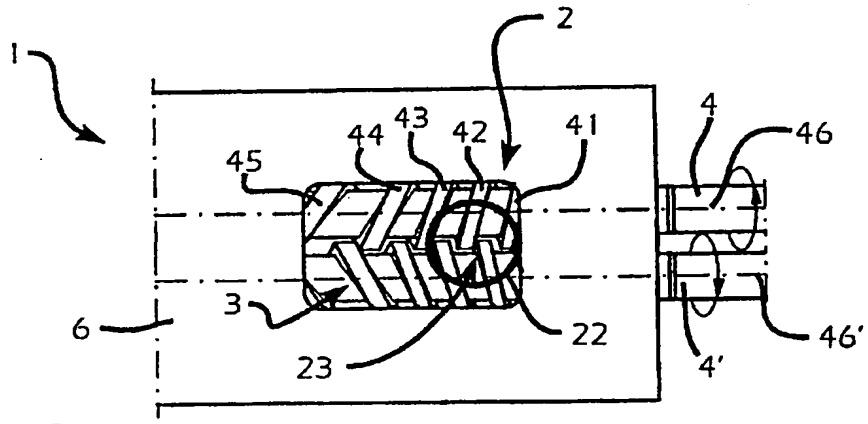
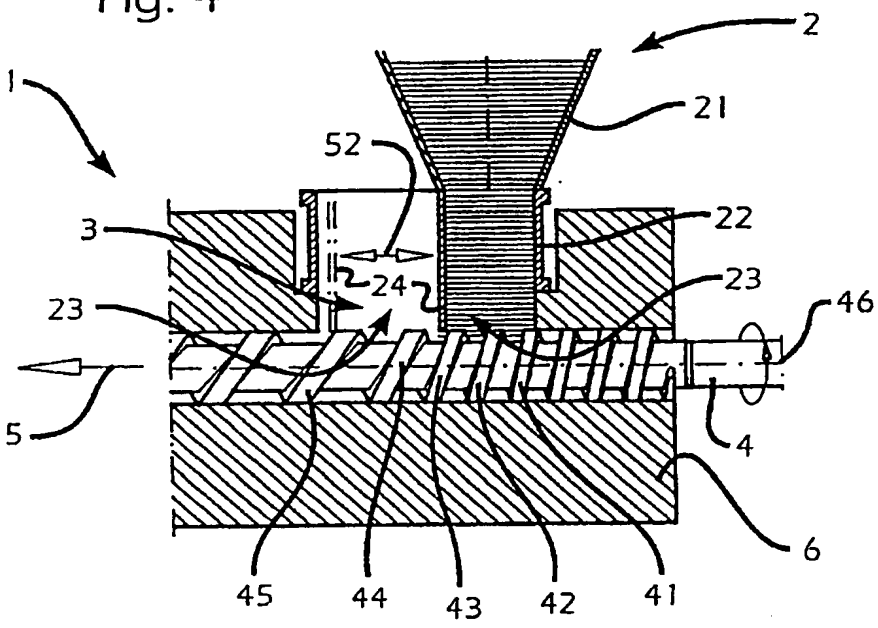


Fig. 3

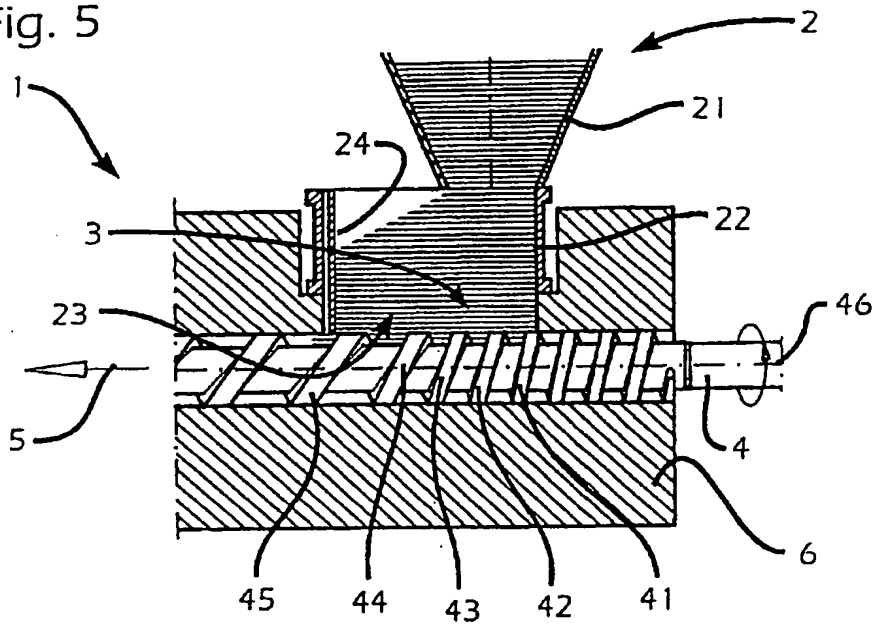
Fig. 4



DRAWINGS - PAGE 3

Number: DE 44 10 932 A1
Int. Cl.[6]: B 29 C 47/10
Publication date: October 5, 1995

Fig. 5



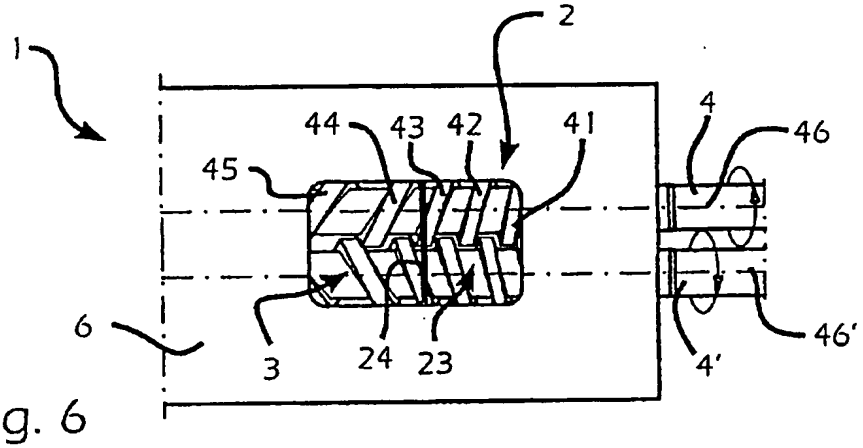


Fig. 6